DOCUMENT RESUME

ED 044 897 EM 008 430

AUTHOR	Bardwell, John D.
TITLE	Toward a New Hampshire Information Network: A Study of the Feasibility of Establishing Educational Information Links Between Keene State College, Plymouth State College and the University of New Hampshire, Carried Out with the Support of the Ford Foundation.
INSTITUTION	New Hampshire Univ., Durham.
SPONS AGENCY	Ford Foundation, New York, N.Y.
PUB DATE	Jul 70
NOTE	40p.
EDRS PRICE	EDRS Price MF-$0.25 HC-$2.10
DESCRIPTORS	*Communication (Thought Transfer), Educational Television, *Information Networks, Input Output, Library Networks, Mass Instruction, Media Research, Media Technology, National Libraries, Regional Libraries, *Telecommunication, University Libraries
IDENTIFIERS	Data Plex Systems, MCI, Microwave Communications Inc, *New Hampshire Network

ABSTRACT

The use of a microwave network to establish educational information links between four New Hampshire campuses is considered in this report. A budgetary estimate is made for a two-way microwave circuit between these points and a two-way microwave circuit between Durham and Saddleback Mountain. The proposed microwave path, the proposed route for a microwave system, and the proposed and existing educational television network are illustrated. The possibilites that the new technology of information transfer bring to naticnal libraries and university libraries are described. The interface between information seekers and information services is discussed. The conclusion is made that television is uniquely capable of being both the fastest mode of transmission and, through the Data-Plex Systems, the communication system most nearly capable of handling mass traffic loads. (MF)

Toward A New Hampshire Information Network

By John D. Bardwell

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION
THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL OFFICE OF EDUCATION POSITION OR POLICY.

ED044897

EM008430

ED 044897

Toward A New Hampshire Information Network

A study of the feasibility of establishing educational information links between Keene State College, Plymouth State College and the University of New Hampshire, carried out with the support of the Ford Foundation

John D. Bardwell

Principal Investigator

Published by the Audio Visual Center
The University of New Hampshire at Durham
July, 1970

Contents

Introduction 5

Part I

Toward A New Hampshire Information Network 8

Software and Hardware 8
Information-Seeking Behavior 9

Part II

Information Technology 12

The Need 12
Approaching the Problem 15
Input-Output Techniques 16

Part III

The Development of Regional Information Systems 18

State University Libraries 18

The Educational Communications System 20
Other Projects 22

Part IV

A Microwave Network for New Hampshire 23

The New Hampshire Network 23
Durham, Plymouth, Keene Interconnections 23
The MIC Concept 28
Transmitting Special Program Material 31
Summary 32

Part V

The Behavior of Information Seekers 34

The Problem 34

Bibliography 38

Introduction

This is the final report of the "New Hampshire Information Network Study" — a study of the feasibility of establishing educational information links between Plymouth State College, Keene State College, the University of New Hampshire main campus in Durham, and a future University branch in Manchester. The study was based on a specific need to explore the use of educational television as a means of sharing instructional resources. It did not stop there, however, because the investigators felt that the situation in New Hampshire could serve as an appropriate model for other states. The following conditions could be applied to many information networks:

1. Audio, video, and data signals can be transmitted between institutions.

2. User profiles can be based on faculties at a large university (UNH/Durham) and smaller state colleges (Plymouth and Keene).

3. Information needs and communication patterns can be based on relationships between a information-producing institution (the University) and an information-using institution (the State College).

4. Information needs and communication patterns can be based on relationships between a university branch campus on the one hand, and a university or state college on the other.

5. Information needs and communication patterns can be based on relationships between the two state colleges with similar patterns of operation.

6. Information needs and communication patterns can be based on relationships between state information networks (in this case, networks in Maine, New Hampshire, and Vermont).

As a first step, the investigators studied the technical prob-

lems of interconnection as they relate to information technology. After a review of the literature in this field, it was obvious that *this society has the technological skills to build devices to meet any anticipated need.* The investigators also studied a number of regional interconnection projects, existing and proposed. It was felt that this might result in a broader, more comprehensive system for New Hampshire. As a result, it was determined that *a microwave system between the three campuses would be more useful if it would carry audio, video, and data signals,* and not just television alone.

In the second phase of the study, resource teams were developed to consider problems relating to the information network, and appropriate commercial agencies were invited to prepare plans for microwave links. It soon became apparent that *it would be more economical to share the system with other small colleges in the state.* Similar programs in Vermont and Maine were considered in order to make appropriate provisions for future linkage between the three state information systems. Consideration was also given to the electronic equipment already available on each campus; however, it was understood that future systems would require new encoding and decoding devices, with increased capability. The investigators were not seeking a single, integrated, "all purpose" system, and foresaw that linkage might eventually be achieved by the interconnection of several independent systems, coordinated to provide different types of access to information.

The next step was to explore the information-gathering behavior of college faculty members. Availability of information implies that we are able to identify the user, determine what type of information he uses or wants to use, discover where he wants to use it, and how he wants to use it. This study attempted to identify the information-gathering behavior of users and systems that would satisfy this definition of "availability." The literature in the information sciences indicated that *most information systems have a relatively low rate of utilization* because faculty members found them inconvenient to use. It was the purpose of this aspect of the study to develop a model of the behavior patterns of information seekers and contribute to the design of information systems that provide a maximum amount of relevant data with a minimum amount of effort by a faculty member.

The final step was to prepare an "action plan" to enable the University of New Hampshire and the two State Colleges to take specific steps to implement the proposed system.

Part I

Toward A New Hampshire Information Network

"I remember well during the war when at a conference to unify military information services, the chairman . . . showed us the futility of our efforts by remarking that in all of his forty years of experience he had never found anyone who failed to get the information he wanted, provided he knew the right person to ask." — Bernal

Software and Hardware

It has been estimated that a two-way "loaded" microwave system could be provided for $515,000, if the existing facilities of the New Hampshire Network could be shared. Such a system would provide links between Plymouth State College, Keene State College, the University of New Hampshire, and the Merrimack Valley Branch. In addition, the system would be accessible to most of the smaller colleges in New Hampshire, including the eight colleges in the "New Hampshire College and University Council."

Technical specifications have been provided for the microwave links, and they have been reviewed by a registered television engineer. Again, they support the feasibility of such a system.

The College and University Council has met several times with Charles Morchand of Data-Plex Systems, Inc., and representatives of the Riverside Research Institute. It has been proposed that the facilities of the New Hampshire Network be used to field-test a library information system that would provide rapid, inexpensive facsimile transmission between the libraries of the eight institutions. Prototype devices are now being developed by Riverside Research Institute for Mr. Morchand. The Council has indicated its interest in the project which would include Keene, Plymouth, and UNH/Durham.

Dean Seibert, associate dean of regional affairs for the Dartmouth Medical School, is exploring the use of two-way television for medical education. Preliminary discussions have focused on using existing ETV microwave "quiet hours" to transmit between Dartmouth Medical School and the University of Vermont Medical School. Another plan is to interconnect the University of New Hampshire with Mary Hitchcock Memorial Hospital in Hanover to facilitate the training of medical technologists. Discussions have been initiated to examine possible uses of the existing network during periods when it is not being used for regular programs.

The New England Library Information Network has received its fifth grant from the Council on Library Resources to assist in the creation of a computer-based regional center, operated to provide technical services to the libraries of New England. Six libraries are now interconnected by a teletype network to an experimental computer installation. Designed initially for college and university, the Network will, when fully operative, be capable of providing services to state libraries systems as well. It is anticipated that the project will be capable of handling these services for as many as sixty-four libraries within the near future. This number will be expanded as rapidly as the project acquires greater computer capacity.

In addition to book cataloging services, the center will serve as a connecting link between New England and other computer-based information centers throughout the nation, thus greatly expanding the information base for all users of research libraries.

Information-Seeking Behavior

The use of electronic media to supply graphic output of information has made swift progress in recent years. Important information is becoming available in a variety of easily-understandable, easily-read, and speedily-processed forms. The technologies that make this possible are growing at an increasing rate—faster almost than the knowledge of how this can be accomplished and can be made available to potential users. In fact, the present level of use for such systems is not commensurate with the effort or the expenditure involved in their creation. The interface between the system and the users is relatively inefficient, and in order to achieve the full potential of the storage and retrieval capabilities of these systems, it is import-

ant to be more precise about the characteristics of the interface system.

An earlier study of the feasibility of establishing educational information links between six land-grant universities in New England identified the following questions for further study:

1. What types of spaces must be designed to send and receive information?

2. Where should these spaces be located on the campus?

3. How will such a system change the role of existing libraries, computer centers, ETV studios, and other information agencies?

4. How is the system to be managed and where will the control center be located?

5. What additional personnel will be required and how will they be trained?

A brief study of the behavior of information-seekers on the faculty of the University of New Hampshire has emphasized the need for a "Query Formalizer" who can assist in the search for an unfamiliar source. Professors who demand an increase in holdings while complaining about the overabundance of information may be reflecting the frustrations of an unsuccessful information search. They rarely ask the librarian for the physical location of a known source but they search their personal libraries or ask the advice of a colleague.

This study may lead to a new series of questions about the design of information systems. For example:

1. How can we make personal libraries available to an information seeker who has departed from his own field into an adjacent one in which he does not have personal contacts?

2. Can the interface be improved by providing the services of a "Query Formalizer" who assists the seeker by helping him identify the question that he wants to ask?

3. How can we build in feed-back to the inquirer at various stages in the process?

4. Can we develop a retrieval system that will facilitate the search for an unfamiliar source using the services of a query formalizer to structure the questions and feedback loops to reduce the information field?

5. Can we develop a retrieval system that can be accessed from the work station of the information seeker?

6. Would we receive the same results if we were to conduct

these interviews at small colleges with less adequate library holdings?

These are some of the questions that face the builders of information systems. It is expected that the thrust of the NELINET project, the Dartmouth Medical School program, the College and University Council, and the growth of University branches in Manchester, Berlin, and other locations will cause us to continue our search for new answers . . . . and our search for the right person to ask.

Part II

Information Technology

The Need

In the December 1966 issue of EDUCOM, Burton Adkinson pointed out the need for a "national system" of library information services for researchers, practioners, and students.

Among the ongoing activities intended to strengthen library services are these: (1) experiments at the Library of Congress, National Library of Medicine, and Yale University to develop automated catalogs; (2) the development of national abstracting and indexing systems organized along scientific discipline or other topical lines susceptible to the maximum possible mechanization of processing and interchange; (3) experiments to speed up the increased flexibility in primary publications, such as are now being conducted by the American Chemical Society; and (4) other specialized projects which include library activities as part of their area of interest, such as Project Intrex at M.I.T., the American Institute of Physics information project being pursued in cooperation with Project MAC at M.I.T., and the development of the interuniversity communications network known as EDUCOM.

Mr. Adkinson felt that, since no library can be self-sufficient either in comprehensiveness of its collections or preparation of indexes and catalogs, a national system must evolve. This will include one or more national libraries that will prepare automated catalogs and indexes of materials in its field; plus regional and state systems using the products of the national, regional, and state systems and developing their own specialized tools and services.[1]

Since these systems will not evolve without planning, it is

---

[1]Adkinson, B., "National System for Libraries," *EDUCOM* vol. 1, no. 8:11, December, 1966.

incumbent on national, regional, state and local organizations to begin to plan for their own specialized tools and services.

In the university of the future, as it is visualized at M.I.T., the library will be the central facility of an information-transfer network that will extend throughout the academic community. Students and scholars will use this network to gain access to the university's total information resources, through touch-tone telephones, teletypewriter keyboards, television-like displays, and quickly-made copies. The users of the system will communicate with each other as well as with the library; data just obtained in the laboratory and comments made by observers will be as easily available as the texts of books in the library or documents in the departmental files. The information traffic will be controlled by means of the university's time-shared computer utility, much as today's verbal communications are handled by the campus telephone exchange. Long-distance service will connect the campus information-transfer network with sources and users elsewhere.[2]

An intercommunications network is being planned for the fifty-eight campuses of the State University of New York that will make the total library holdings available to every faculty member and every student on every campus. Dr. Ernest Boyer, executive dean for University-wide programs, believes that some learning can be accomplished by computer-assisted instruction, and that closed circuit inter-campus television conferences can be available twenty-four hours a day throughout the entire broadcasting system.

Telefacsimile and computerized print-outs make feasible the prospect of study terminals located in dormitories, in apartments, in libraries, and in student unions, so that the stored resources of the institution and its fact-transmitting system can be available twenty-four hours a day throughout the entire university.[3]

The medical libraries of three major eastern universities will be tied together in a network of computers and telephone lines to give scholars virtually instant access to their pooled resources of 1,025,000 items. These can be searched by computers in seconds. When telecommunication and photographic devices

---

[2]Marke, J. J., *Copyright and Intellectual Property*, p. 90.

[3]Boyer, E. L., "New Ties That Bind SUNY," *EDUCOM* vol. 1, no. 4:1, April, 1966.

are added to the network system, pages from a book in New York could be flashed to a user in another city and even reproduced for him in take-home form.[4]

The computer's participation in the field of learning will continue long after the end of formal education. The government estimates that fifty percent of the jobs to be held ten years from now do not even exist today. With this tremendous rate of occupational obsolescence, future generations of Americans may pursue two or three careers during their lifetimes. Home access to information systems will contribute to the development of career mobility by providing continuing self-instruction.[5]

At the turn of the century, most large universities will not only have electronic composition systems that allow them to reprint original research, theses, or course notes upon demand; they will also have a computerized information retrieval library that can supply a scientist with the latest technical papers culled by the computer and reproduced in the laboratory or home. It will provide the attorney with all the pertinent laws, decisions, and precedents on any case that concerns him. The business executive need not rush to the office every morning; most of the information that he will need to conduct his business will be run off for him at home, and he will have two-way national and global closed-circuit television, via satellites, for meetings and conferences.[6]

Adding tremendous impetus to the technological explosion is the fact that, as computer capabilities are increasing, costs are decreasing. Between 1963 and 1972, there will be a decrease of 85% in the cost of completing a typical data processing job. During this period, the cost of image storage will decrease by 96%; and communication line costs, because of increased speeds of transmission, will decrease by 50%. These changes mean that we will be able to do more with information technology than we now can even imagine.[7]

In education, the industrial revolution has begun—slowly, to be sure, but irresistibly, and with the most profound consequences for both education and industry.

---

[4]Marke, *op. cit.*, p. 91.

[5]Sarnoff, D., "No Life Untouched," *Saturday Review*, p. 22, July 23, 1966.

[6]*Ibid*, p. 22.

[7]Diebold, J., "The New World Coming," *Saturday Review*, pp. 17-18, July 23, 1966.

The past few years have seen an explosion of interest in the application of electronic technology to education and training. Business has discovered the schools, and neither is likely to be the same again.[8]

In time, the application of electronic technology can and will substantially improve the quality of instruction. But a lot of problems—in hardware as well as software—will have to be solved before the electronic information systems and instructional devices find wide acceptance in education.[9]

Approaching the Problem

In 1964, a small group of men concerned with medical education met to consider how advances in communication and learning technology could be applied to the education of medical students and to the continuing education of practicing physicians. As the discussions progressed, it became clear that they should be concerned with the whole range of disciplines and professions, and that the problems could best be considered on a multi-institutional basis. As a result of their concerns, the inter-university Communications Council (EDUCOM) was incorporated in the State of Michigan.[10]

Since its founding, EDUCOM has attempted to provide a focal point for the development and application of technology to educational communication. Its interests might be divided into four categories:

First, technological aids to instruction. These range from slide projector through television and are used to extend the teacher's instructional capabilities beyond his own words and demonstration.

Second, technological aids to the learner. The emphasis is on devices to help the process of self-instruction. The hardware starts with the printing press and goes through the complex process of computerized programmed learning.

Third, technological aids to research. The research worker is particularly interested in systems for the collection, classification, storage, and retrieval of information.

Fourth, the application of technology to the administration

---

[8]Silberman, C. E., "Technology Is Knocking at the Door," *Fortune*, p. 120, August, 1966.

[9]*Ibid.*, p. 121.

[10]Montgomery, E., "EDUCOM — The Evolution of an Idea," *EDUCOM* vol. 1, no. 5: 1, May 1966.

and operation of colleges, universities, hospitals and clinics.[11]

EDUCOM is planning a prototype information-processing network which may link campuses with a telephone-line network through teletypewriter terminals. Material will be stored on-line—either on a central computer or on time-sharing systems of participant institutions.[12]

Input-Output Techniques

Improvements in input-output techniques can lead to the proved performance in all parts of the computing process. New kinds of input equipment make it possible for computers to accept directly a wider variety of information. For example, the recent development of stylus devices, such as the "Rand Tablet," enables the computer to interpret human sketching. It is now possible to put diagrams and sketches into the computer without the time-consuming process of reducing them manually to numerical coordinates.

Improvements in the speed and organization of input-output systems can reduce computing costs. The "interrupt" systems reduce computing delays by allowing several input and output operations to proceed while computation is being done. New kinds of output equipment enable computers to produce output in more directly usable forms. A graph is often much more useful than a column of numbers.[13]

The basic hardware for graphical output is the cathode-ray-tube display. When given a set of coordinates by the computer program, a simple CRT display will flash the corresponding spot on its face. Complete pictures including lines, curves, and letters can be made up out of thousands of individual spots. Because the display is entirely electronic, it can work very fast; a single, spot may take only a few micro-seconds to show.[14]

The stylus-photocell arrangement called the "light pen" has a photocell placed in a small hand-held tube. Such a system can quickly copy any part of a drawing. It can also erase without a trace, (or temporarily if he prefers) any unwanted line that the operator points to. It can stretch parts of the drawing to make them fit with other parts. It can move lines which the

---

[11] *Ibid.*, pp. 1-2.

[12] "Network Study," *EDUCOM* vol. 1, no. 5: 12, May 1966.

[13] Sutherland, I. E., "Computer Imputs and Outputs," *Scientific American* vol. 215, no. 3: 86, September 1966.

[14] *Ibid.*, pp. 92-94.

operator has already drawn, or refuse to draw lines that are meaningless in the context of the work at hand. Because the drawing is built directly into the computer's memory, no complicated pattern-recognition programs are required. A stylus-input device therefore provides a convenient method for getting diagrams, circuits, geometric shapes, chemical symbols, and other pictorial data into a computer.[15]

Time-sharing is a technique whereby a computer serves a large number of people simultaneously. In addition to allowing fuller use of the machine by more people, it also enables the user to conduct a continuous dialogue with the machine. Further, the system makes it possible for the users to carry on a discourse with one another through the machine, drawing on its large store of knowledge and computing speed as they do so. It can unite a group of investigators in a cooperative search for the solution to a common problem, or it can serve as a community pool of knowledge on which anyone can draw according to his needs. One can conceive of such a facility as an extraordinarily powerful library serving an entire community.[16]

A typical time-sharing system contains a large store of information—supervisory and utility programs, language-translation facilities, a library of sub-routines and so on—adding up to nearly a million computer words or 2,000 book pages crowded with nonredundant symbols.

The system also contains a great variety of special programs that are available for general use. To all this "public" information there is added a large amount of material consisting of individual users' private files of programs and information.[17]

The owner can command the system to print out a list of files in his file directory. He may also authorize the system to allow other named users to use his file, and conversely may gain access to other private or public files he is permitted to use. Although a person given access to someone else's file is not usually allowed to change that file, he can copy its contents, file the information separately under his own name, and then modify the data or program to suit his own purpose.[18]

---

[15]*Ibid*, p. 95.

[16]Fano and Corbato, "Time-Sharing on Computers," *Scientific American*, vol. 215, no. 3: 129, September, 1966.

[17]*Ibid.*, p. 130.

[18]*Ibid.*, p. 132.

Part III

The Development of Regional Information Systems

State University Libraries

Librarians of six New England state universities are currently involved in a study to develop a detailed design and set of operating specifications for a regional computer processing program for library technical processing. Given an accurately designed system and suitably programmed information, a computer could substitute machine processing for most of the manual processing and could speed standardization by incorporating the necessary Library of Congress data.

Each of the state university libraries could be individually computerized in the years to come, or a regional processing center with telecommunication links to each of the six libraries could be established.

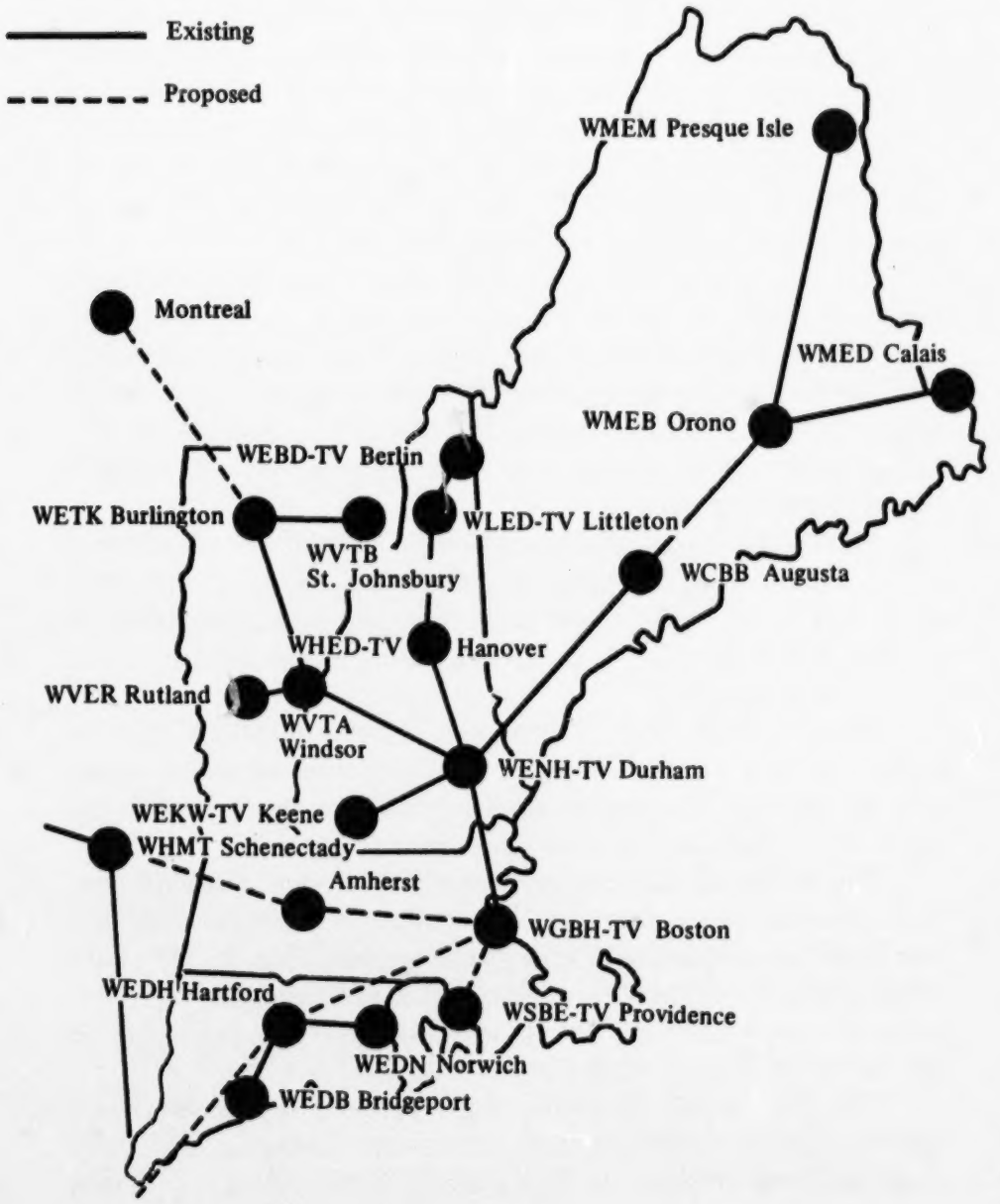
Cooperation among the libraries is facilitated by the fact that their holdings overlap by as much as forty percent. Thus, instead of exactly duplicating the work of five other libraries, each could supply the computer with catalogue data for one broad subject area and the computer would in turn provide catalogue sets for all six. Once the system is in operation, the computer will continue to accumulate, store, and process catalogue data. It will make new subject headings, list appropriate cross references, and produce special bibliographies. Eventually, consoles will provide remote access for professors and students to the home library catalogue, or the catalogues of any of the interconnected libraries.

Such a system eliminates duplication of time-consuming procedures and standardizes the catalogue system. The library user will save time, be able to locate inaccessible or rare books, and have immediate access to specialized reference lists.[19]

---

[19]NEBHE, "Regional Library Computer Center Under Study," *Higher Education in New England* vol. 10, no. 3: 1,7, Autumn, 1966.

Figure 1: ETV MICROWAVE NETWORK



The Educational Communications System

Phase III of the Educational Communications System project was to design three model systems of multi-purpose electronic interconnections for American colleges and universities. It is part of a growing complex of interconnection studies, plans, and operating systems. Interconnected television networks are operating or are in advanced planning stages in approximately twenty states. Under the impetus of such developments as Project MAC and INTREX at M.I.T., time-sharing computer techniques demonstrate the wisdom of interconnection for computer use. Projects such as MEDLARS at the National Library of Medicine obviously tend toward interconnection.[20]

The major premise of the Education Communications System is a major technical premise that more, and increasingly valuable, communication services might be feasible if transmission facilities were used on a multi-purpose basis, shared where necessary. Other factors include the emergence of national information centers and such innovations as regional educational laboratories.

The fundamental tasks of ECS were to establish educational specifications which appear to reflect the needs of potential users and to translate these into technical and administrative designs which satisfy these specifications while taking future growth into account.[21]

Phase III of the Educational Communications System study provides technical designs, administrative structure, financial information, and evaluation guidelines for three model versions of an Educational Communications System.

The technical designs are provided in two versions; one based essentially on the telephone companies' telpak tariff and one based on a broadband microwave system. This design phase was undertaken following surveys which indicated that a multi-purpose communication system was essential and inevitable in the future of higher education.[22]

The ECS report describes three systems which share numerous service functions, but which are intended for three quite different settings: within a single state (Oregon), within

---

[20]Witherspoon, J. P., and others, *Educational Communications Systems: Phase III*, p. 1.

[21]*Ibid.*, pp. 1-2.

[22]*Ibid*, p. 260.

a region (the Midwest), and a model involving "resources" rather than universities per se. The system's basic requirements are increased communications (in various modes) with professional counterparts on other campuses; easier administrative communication, both to ease coordination within university systems and to facilitate cooperative efforts among autonomous universities; maximum use of expensive computation and communication equipment; an interconnected broadcasting network; and wider cooperative use of library resources and information centers.

The study appears to have implications for the development of state and regional networks which heretofore have been single-purpose in nature, generally having been established for educational television transmission. There are implications also for communications common carriers, since some of the implications explored in the study are at variance with the traditional common carrier practices.[23]

A partial inventory of communications hardware would include the following:

Slow Scan Television: Relatively inexpensive TV transmission and receiving equipment which provides for an exchange of still pictures via phone lines. It will transmit anything that TV camera can pick up. Hard copies may be obtained at the receiving end.

Electrowriting: This device permits the "transmitter" or writer to make handwritten notations, drawings, etc., which are simultaneously and mechanically reproduced and may be projected at the receiving locations. When combined with telephonic communication, visual, as well as audio information, can be transmitted.

Teletype: A network of typewriters linked together by phone links makes possible the rapid exchange of typewriter messages between stations. Present technology also permits teletypewriters to query and receive information from a central computer location.

Telelecture: Permits a guest speaker or lecturer to address groups at scattered locations by telephone from his own lecture station. His voice is amplified through a simple speaker system in the receiving location. Two-way communication to handle questions, reactions, and comments is easily achieved.

[23] *Ibid.*, p. 264.

Dataphone: A flexible service which permits normal conversation between individuals over a pair of phone lines at one moment—and through a simple switch can connect business machines or computers to permit data flow over the same lines.

Facsimile: This is a process of transmitting copies of printed or flat graphic material from one point to another. It would enable libraries to transmit copies of pages from a reference book.

Computer Assisted Instruction: The computer presents material to the student and accepts the typewritten responses. The material can be displayed on a screen or typewriter or both. The student responds to the material by operating a typewriter-like printer keyboard which is keyed directly to the computer.

Videofile: A single 4800' x 2" video tape will store over 100,000 separate magnetically-recorded images or pages. Any selected page may be instantly retrieved as a printed (electrostatic) copy or as a displayed image on a television monitor. Images can be selectively erased and replaced, and the entire file can be duplicated in a few minutes.[24]

Other Projects

The University of California at Davis and the University of Nevada are installing a facsimile link for the inexpensive transmission of printed and graphic materials between libraries. A somewhat more flexible interconnection exists between northern and southern campuses of U. C.; for some years Stephens College has been the center of a group of Missouri Colleges linked by an amplified telephone (telelecture) system.

The National Library of Medicine has recorded on computer tape bibliographic references to all periodical literature in medicine for the past several years. A small but complete teletype network serves libraries associated with the large Enoch Pratt Free Library in Baltimore. A larger, more diffuse program involves libraries in the Rocky Mountain-Great Plains area served by the regional bibliographic center at the Denver Public Library.[25]

---

[24]*Ibid.*, pp. 270-271.
[25]*Ibid.*, p. 276.

Part IV

A Microwave Network for New Hampshire

The New Hampshire Network

Since the Fall of 1967, the operation of four UHF stations in the New Hampshire Network have made the Channel 11 signal available to the entire state. In addition, six translators were also planned. The translators, which are low power repeaters used to fill in specific shadowed areas of limited size, would be strategically located as required.

The UHF stations are connected to Channel 11's transmitter on Saddleback Mountain in Deerfield by microwave relay. The four stations, the microwave systems, and the translators were made possible by capital funds from the state and federal governments.

Channel 40, WEDB, serves the Berlin area from its transmitter located on Pine Mountain in Gorham. Operating with 12,000 watts, Channel 40 provides a signal for a radius of 15-20 miles.

Channel 49, WLED, serves the Littleton area from its transmitter on Mann Hill, north of Littleton. Operating with 35,000 watts, Channel 49 provides a signal for a radius of 20-30 miles.

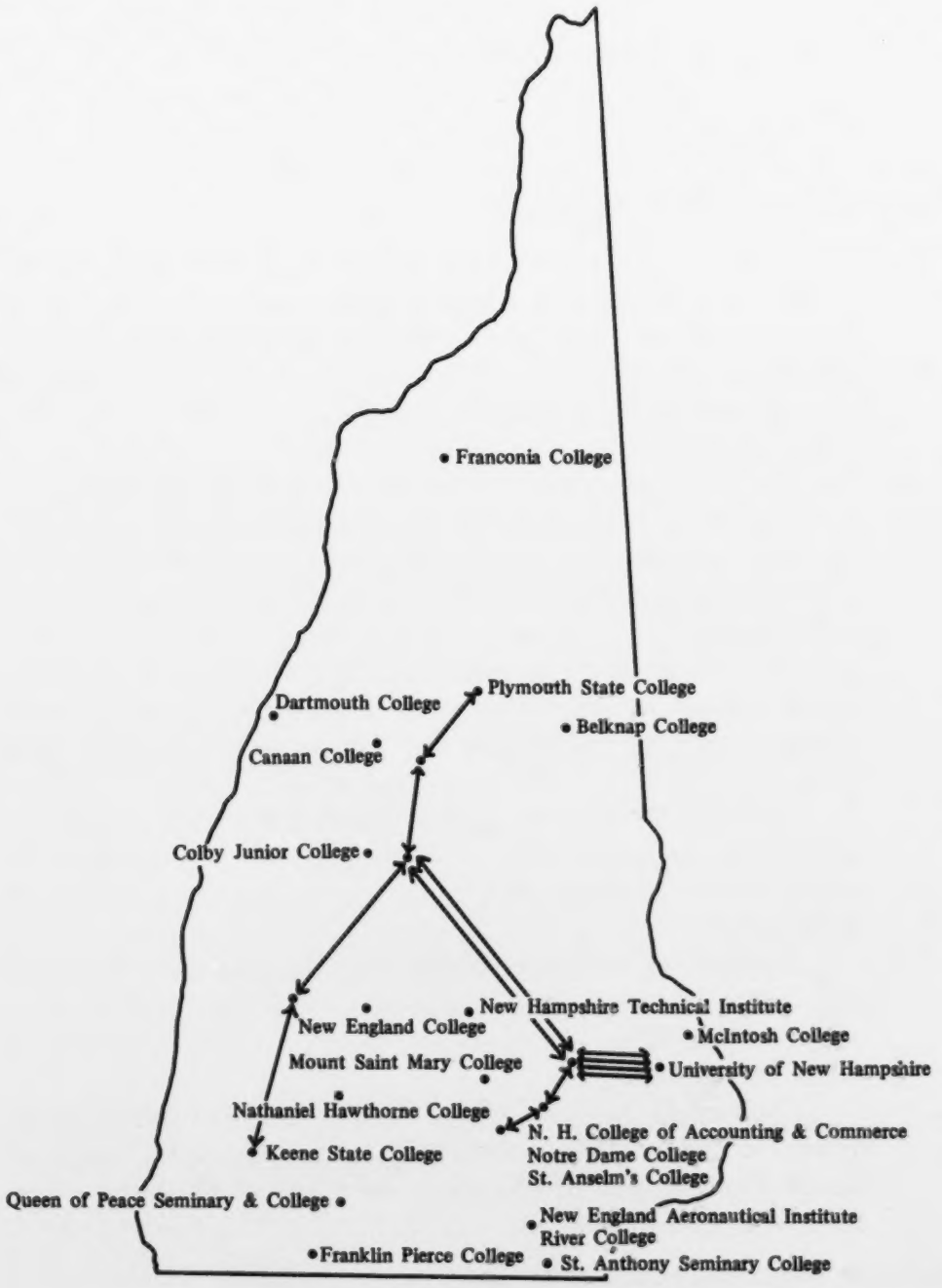
Channel 15, WHED, serves the Hanover area from its transmitter on Moose Mountain, about eight miles east of Hanover. With 30,000 watts of power, the signal covers an area of about 20-30 miles.

Channel 52, WEKW, serves the Keene area from its transmitter on Derry Hill in Walpole, about six miles north of Keene. Operating at 37,000 watts, the Channel 52 signal covers an area of 20-30 miles.

Durham, Plymouth, Keene Interconnections

A proposal was received in response to a request for a

Figure 2: PROPOSED MICROWAVE PATH



budgetary estimate for two-way microwave circuit between Durham and locations in Manchester, Plymouth, and Keene. A two-way circuit between Durham and Saddleback Mountain was also included in the estimate. Figure 2 illustrates the system routing assumed for estimating purposes.

Operation in the 7 GHz television STL and Intercity Relay Band has been assumed for purposes of this estimate. If operation in another band is contemplated, the equipment cost will vary somewhat.

Each two-way circuit, with the exception of the circuit from Durham to Saddleback, is equipped to simultaneously carry the following information:

1. Wideband color video signal
2. 15 KC program audio
3. 48 KC data channel
4. Five 4 KC telephone channels
5. Service channel for maintenance communications
6. Fault and alarm tones for system monitoring

The circuit between Durham and Saddleback Mountain is not equipped to carry either the data or telephone channels, although it will do so with the addition of the terminal devices.

All information, other than the color video signal, is carried by means of subcarriers at frequencies above 6 MHz superimposed on the microwave baseband.

The KTR-3A heterodyne radio is a 10-watt system designed for long haul microwave systems. This equipment is completely solid state except for the traveling-wave tube which serves as the transmit power amplifier.

Pricing Summary

Radio Equipment 7 GHz	$396,645.00
Power	12,642.00
Equipment	16,260.00
Wave Guide	9,910.00
Branching	576.00
Towers and Buildings	17,000.00
Multiplex Equipment	18,930.00
Installation Service	43,200.00
Total Budgetary Estimate	$515,163.00

This system makes available a video channel with audio, a data channel, and four voice channels to meet the needs of electronic interchange of information between the terminal

points at Keene, Manchester, and Plymouth. This could embrace such techniques as slow-scan television, electrowriting, teletype, telelecture, dataphone, facsimile, computer connection, etc.

The proposal is offered as a "turn key" installation (ready for operation) which raises the price somewhat. Additionally a circuit to Manchester is included which may be unnecessary for the purposes of the proposed operation. However, it is felt that the installation figure should be retained in the interest of arriving at a final solid amount with respect to the cost of the microwave equipment.

The manner in which the base band (the video and three subcarriers) is utilized makes it compatible with the State of Maine and Vermont systems. If the Keene-Plymouth experience is favorable, and it is desired to extend to either the Maine or Vermont systems, this can be done. It will require special terminal equipment at the locations chosen and the substitution of heterodyne repeaters where demodulation is now installed.

It should be pointed out that the proposal is based on the assumption of using 7000 MHz frequencies. These may not be available. In the event that they are not, the cost may increase 10 to 15 percent and would suggest the need to include a contingency figure in the listed microwave costs.

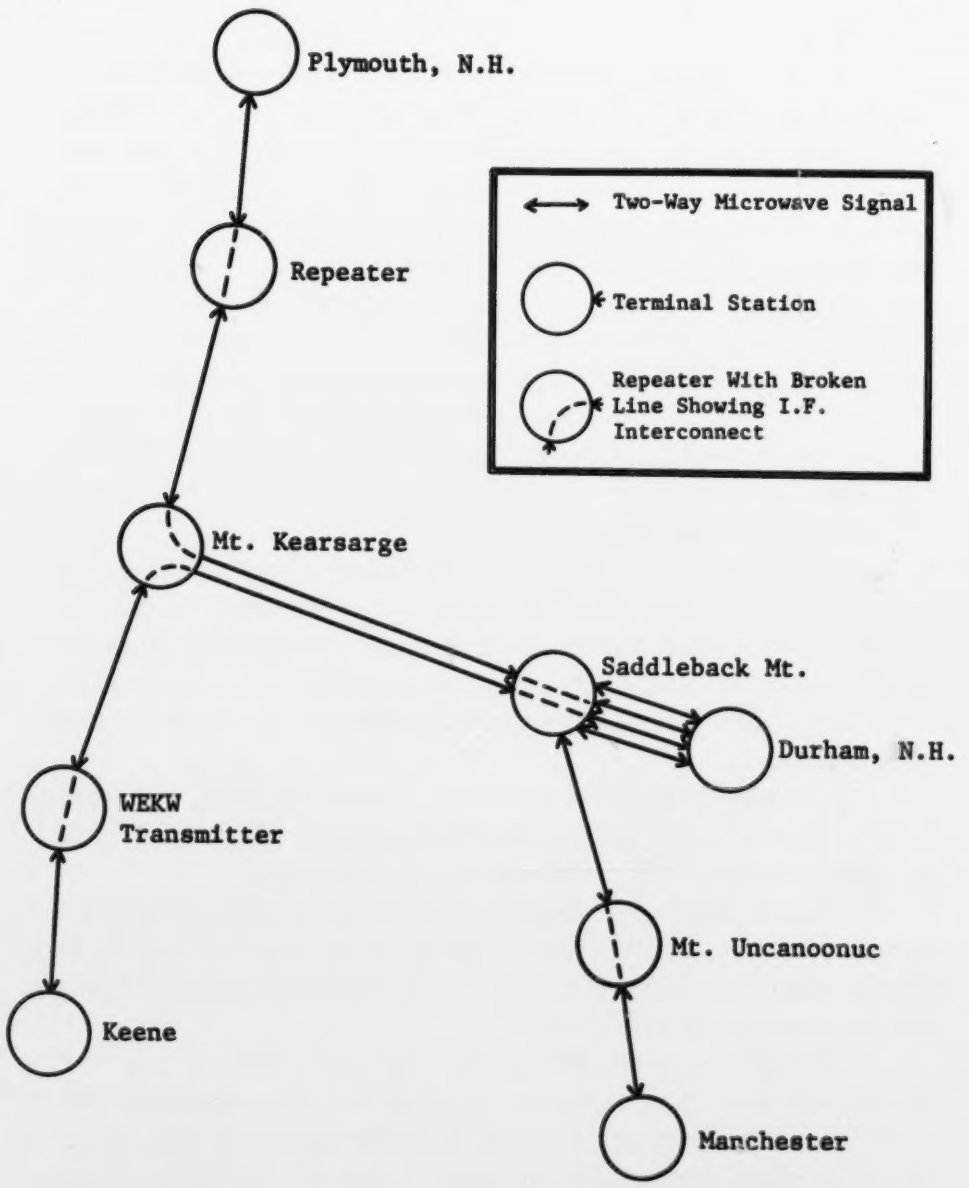
As proposed, the system meets the anticipated requirements of the Educational Information Link.

Information available from those familiar with Educational Television operations, computer installations, radio and broadcast installations, can provide a reasonable indication of operating costs. Roger W. Hodgkins, the consulting engineer for this project, has based his estimates on information obtained from active engineering departments in the region.

Operational Costs (Yearly)

Two engineers	$16,000
Power 2c KWH	1,652
Transportation, 15c mile	3,000
Insurance	200
Maintenance parts	10,000
Two way radio	1,000
Rentals	2,400
Unclassified, (Contingency)	6,800
Total	$41,052

Figure 3: PROPOSED ROUTE FOR MICROWAVE SYSTEM



The State of Maine Educational Television Network has maintained accurate records of microwave maintenance and operational costs, and it is suggested that these be quoted as representative of realistic expenses connected with this phase of microwave ownership.

The MIC Concept

"Special Service Common Carriers" are communications carriers specializing in serving a submarket in the communications field. Microwave Communications, Inc., (MCI) has proposed to establish a low-cost nationwide communication network to interconnect universities and colleges for the sharing and transfer of data and other information and to interconnect non-commercial educational broadcasting stations.

This educational network would utilize the towers, antennas, and sites of existing CATV microwave carriers and the newer MCI type of "Special Service Common Carrier" for the location of the transmitting and receiving equipment necessary for this network.

MCI'S proposal would:

1. Foster the development of new and needed educational facilities and services through an exchange of educational programs and the sharing of such educational resources as libraries, faculties, research and laboratory installations, computer hardware and software, and other capabilities of institutions of higher learning.

2. Offer to EDUCOM facilities for the national, inter-university, computerized communications network which EDUCOM in 1966 petitioned the Commission to authorize.

3. Permit public broadcasting stations to transmit and receive interconnected intercity services twenty-four hours a day, seven days a week, as contrasted with the current two hours per day, five days per week availability.

4. Extend to both EDUCOM and the CPB stations full control and use of a complete nationwide communications network, dedicated exclusively to educational purposes and unhindered by tariff restrictions on rates, hours of operation, classifications, practices and facilities.

5. Relieve the burden imposed on existing carriers, their customers and their stockholders, because of the impact of provision of service at rates below cost.

Under MCI's concept, the educational entities would have

complete control over this network. Priority of operation, scheduling, timing, relaying, expansion, switching, etc., would be as the educators dictate and would not be dependent on the existing tariffs and facilities of the present carriers, nor be subject to the planning or lack of planning of these carriers. The educational entities would be in a position to expand or change this network to meet their own requirements.

In order to arrive at the operating cost, it is necessary to know the approximate initial cost of installing this network. This is essential regardless of who owns, operates, or maintains this network.

The following cost figures are estimated and are believed to be reasonable. Video channel conditioning equipment costs are not shown since this item might be more appropriately shown in the local channel costs. The facilities or type of transmission will vary in this educational network depending upon the location — i. e., if it is part of the backbone system, a spur, or terminal.

There are three basic types of microwave systems: heterodyne, remodulation, and TDAM (tunnel diode amplifier microwave station). The type of system used depends on the length of the system.

Heterodyne Repeater: A heterodyne system is necessary on long haul routes. It can be several thousand miles in length and still provide signals meeting NTSC color TV noise test of 48 db PP/RMS signal-to-noise. This level of noise in a picture is unnoticeable even on close examination. The heterodyne system is the most expensive. At the repeater sites, the signal is brought down to an IF frequency which is then fed into the transmitter for re-transmission to the next site. A typical cost for this type of equipment is the Collins Model MW109E. (List Price $11,000).

Remodulation Repeater: A remodulation system also provides signals meeting the NTSC color TV noise test and is used for short or medium haul routes. The normal distance of these systems are generally 15-19 repeaters which is in the 500-600 mile range. It is possible to come off a heterodyne backbone system with a remodulation system. This would reduce the total cost while, at the same time, it would not degrade the picture quality. This is a moderately priced microwave system. At the repeater sites, the signal is brought down to the base band which

is then remodulated by the transmitter and sent to the next site. A typical cost for this type of equipment is the Collins Model MW108D. (List Price $6,285).

TDAM System: This is a new technology. Several companies are in the process of marketing this equipment. This type of system differs from the heterodyne and remodulation systems in that it amplifies the actual RF signal and retransmits it to the next site. The anticipated cost of this type of repeater would be about one-half of that shown above and would be used for both long and short haul systems due to its low cost and low noise factor.

The above prices are for the latest solid state design. Tube units would be considerably less. With the large number of units needed for this network, a discount or reduction in cost of up to twenty percent could be expected through competitive bidding.

Annual Carrying Charge Factor.

Depreciation (Based on 7% Salvage and 16-Year Service Life)	.058
Maintenance	.084
Administration	.054
Total Expenses	.196
Annual Carrying Charge Factor	Say 20%

An educational network interconnecting the Educational Television and Educational Radio Broadcasting stations under MCI's concept would have such flexibility that future expansion and innovations would be limited only by one's imagination.

These innovations to the basic educational network can be implemented in various phases to correspond with the finances, needs, and experiences of the network. For example:

Phase 1: The initial one-way, basic network to interconnect various ETV stations.

Phase 2: Superimpose on this network audio channels that could be used to interconnect the various educational radio broadcasting stations.

Phase 3: Simple, inexpensive antenna switching devices could be installed at various sites enabling the reverse of the direction of the network. This would enable local ETV stations to distribute their programs over the network.

Phase 4: Installation of video and audio recording equipment

at several locations for local distribution of programming material. This equipment could be automatically engaged during hours of non-network programming.

Phase 5: Establishment of diverse routing and switching capability.

Phase 6: Addition of greater channel capacity.

Phase 7: Addition of computer facilities which could be shared by all of the educational stations.

The proposal by Microwave Communications, Inc., to create and operate a nation-wide ETV microwave is feasible. However, it is subject to approval by the F.C.C., and involves a reorganization of the existing telephone company policies. It seems that whatever the outcome of this plan is, it holds no *immediate* attraction to the proposed system to interconnect Keene, Plymouth, and Durham.

Transmitting Special Program Material

Data-Plex Systems, Inc. has devised several methods of expanding the information-carrying capacity of a television channel so that special program material (pages of text or still pictures) can be transmitted along with a regularly broadcast program. The addition of the special material neither reduces the picture quality of the regular program transmission nor interferes with it in any way. A specially equipped receiver enables a viewer to suppress the regular program material and display only the special material which has been transmitted with it. Commercial equipment exists for making a permanent copy of the special material if the viewer should want to do so.

These techniques have applicability where television facilities exist and where additional information transfer capability over existing channels is required. The cost of adding this additional capability to an existing channel will be far less than the cost of installing another, separate television channel.

Data-Plex Systems, Inc., has applied for patents covering these processes and has asked Riverside Research Institute to undertake the development of prototype devices. The development program will take several years, and should culminate in field tests of the prototype devices in situations where the full potential of these devices can be properly assessed. Some of the member colleges of the New Hampshire College and University Council, acting as receivers of special program information sent from the University of New Hampshire over the facilities

of Channel 11 have been requested to participate in these field tests.

Briefly, the Interplex or Data-Plex System is designed for retrieval of texts from microphotographic or digital storage and for transmission of retrieved texts to a requesting agency for display of soft copy or the making of hard copy from a TV display terminal.

In the system, pages of text or graphic matter can be accessed from storage and can be transmitted over any TV channel (via broadcast, coaxial cable, microwave relay, or satellite) at a rate of several pages per second. Any page chosen can be displayed at the requester's TV screen up to fifteen minutes or less if desired. The number of pages transmitted per second can be increased four times by one of the techniques.

The system combines the advantages of television transmission, a quantity of pages per second, economically priced terminals, local and network and international transmission capability (transmits to any locality within range of TV transmission), and the ability to send graphics in halftones and in color. In addition, hard copy facsimile can be made as well as soft copy CRT displays, and the system would be compatible with the fastest (or slowest) automated information retrieval devices whether using microphotographic or digital storage.

The system has been successfully engineered, and within a reasonable period of time, it should be available for demonstration. At the time of demonstration, full budgetary estimates together with delivery schedules will also be available. The technical specifications and projected practical applications of the system have been reviewed by qualified engineers and library personnel; both are eager to experiment with the use of such equipment.

Summary

To conclude, television is uniquely capable of being both the fastest mode of transmission and, through the Data-Plex Systems, the communications facility most nearly capable of handling mass traffic loads. Further design of such peripheral equipment as efficient page turners and techniques for rapid feed of individual pages are necessary before the speeds afforded electronically by television can be matched to manual and mechanical storage and dissemination devices. Also required would be the installation of television receiving equipment in

the communications centers of all agencies, including those designated small requesters. This can be done simply by adapting a standard CRT (commercially produced television set) and adding an inexpensive frame storage device. This television equipment would be much cheaper than any other image or digital transmission and receiving equipment and would enable the agencies to combine in a single system the techniques for receiving their most urgent requests (in color, halftones, etc.) and, on a delayed basis, all other inter-library loan requests (the system's mass traffic load). Equipment such as telephones and teletypes, already installed in agencies for a variety of program and administrative activities, would still be employed for such uses as establishing the bibliographic identity of wanted items and ascertaining their location and availability.

Part V

The Behavior of Information Seekers

The Problem

The problem of developing a comprehensive information system is extremely complex because of the many agencies and individuals who are involved in the subsystems that are operating. A review of the literature in the information sciences reveals a serious lack of research information about the needs of the people who use educational information systems. One researcher suggests that it is probably unrealistic to expect that information users can be educated to use that which is available to them; we should assume that they are "incurably apathetic" toward present services. He believes that services should be changed, not the patrons.

It was assumed that the information gathering behavior of the information user would provide clues that would enable scientists to design more efficient and effective information systems. An attempt to structure such a study was based on the following assumptions:

1. Direct information questions in a person's field may be discounted as "known information" if the respondent "knows" the information or the answer source.
2. The first types of information-seeking behavior tend to be activities that will provide immediate feedback.
3. Immediate feedback tends to reduce the randomness of the search.
4. Randomness may be a function of language.
5. Non-verbal cues from human information sources may increase the effectiveness of the information search.
6. Indirect questions are all part of the feedback loop.
7. The more effective the relationships between individuals, the more effective the feedback loops.

As part of a long-range project to relate the three campuses of the University of New Hampshire to one another in an information system, some characteristics of a user-oriented information system have been explored at the Durham campus. Those involved in the research were aware of the fact that large information processing systems existed, and that these were indifferently used. It appeared that the present level of use was not commensurate with the effort or the expenditure involved in their creation. The implication was that, however technically sophisticated the process might be in data storage and retrieval, the interface between this system and the users was relatively inefficient. In order to achieve the full potential of the storage and retrieval capabilities in these systems, it is necessary to define the approximate characteristics of the interface system.

The research concentrated on the academic user of information and the way in which he went about securing answers to particular kinds of questions. As a first approximation to a model, information-seeking activity was related to three hypothesized levels of query. First, those questions leading to responses that were a matter of fact; second, a matter of process; and third, a matter of concept. It was assumed that the sort of activities undertaken to secure answers for these kinds of queries would be different for each class of query. Early testing of the model indicated that this three-part classification had little meaning. All the individuals with whom interviews were carried out indicated a common mode of approach to securing information without regard to the nature of the question.

The problems that all of them faced were related to the so-called information explosion. In an article published in the *Library Quarterly,* Don Swanson suggests two constraints with which information systems may have to contend. The first has to do with the limit at which information can be absorbed by the human operator and the second, his willingness to exert unusual effort to use a system.

The first constraint suggests the need for condensing information and at the same time evaluating it; the second, ready access. Much of the total physical volume of the information increase is irrelevant to the problem of the individual seeking specific data. On the one hand, subject matter which is well understood has already been compacted many times. Some of

this compacting is of high caliber, and once one of the better sources has been selected, it may make no difference to the researcher if several thousand more are produced (eg. handbooks of linear methods). On the other hand, highly technical new developments are directed at very small audiences. People teaching advanced courses in a field or carrying on research are normally aware of other individuals engaged in similar activity. Information flows between these people by private communication and through specialized publications.

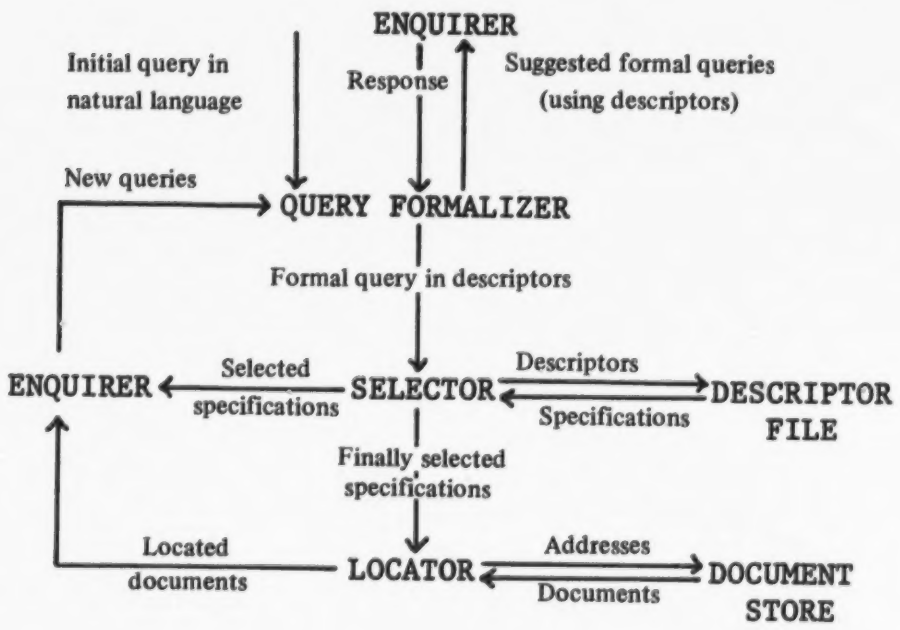
This system has relatively high efficiency for those engaged directly in the field, but is most inefficient for persons outside the field. In fact, many of the publications specific to a given discipline may not be touched by any of the standard abstracting services. Access to, as well as evaluation of, these sources is then an important characteristic.

In the discovery of techniques, especially, there is a good deal of redundancy. Some of this is largely inevitable as researchers approach specific problems from different directions, but eventuate with a common answer. It may, in fact, be more efficient time-wise to "reinvent the wheel" for specific uses than attempt to run down prior inventors whose applications upon close analysis are not identical. Whether in the evaluation of old data or the reviewing and seeking of new, the process at the interface is one of evaluation. As was implied in the preceding paragraph, the most difficult search problems occur when an individual departs from the mainstream of his own field into an adjacent one in which he does not have personal contacts, or when he develops totally new concepts within his own field.

Susan Langer in *Philosophy and the New Key* says, "The process of philosophical thought moves typically from a first inadequate apprehension of some novel idea figuratively expressed to more and more precise comprehension until language catches up with logical insight. The figure is dispensed with and literal expression takes its place. Really new concepts having no names in current language always make their earliest appearances in metaphorical statements; therefore, the beginning of any theoretical structure is inevitably marked by fantastic inventions."

Whether her statement is precisely true or not, it points out that frequently the investigator in a new area is not really cer-

tain what question he wants to ask. A consequence of this uncertainty is the need for interrogation of the seeker by the potential source. The source becomes an active segment of the entire system rather than a passive file waiting to be interrogated (as libraries currently act). Those persons most likely to be effective interrogators are those familiar with the field (or fields) in which the researcher or teacher is working. In effect, what is imperative at the interface between the storage and retrieval systems is some sort of annotated bibliography with extensive feedback loops. B. C. Vickery in a book, *On Retrieval System Theory,* alludes to this need in the following model in which he notes, "For a fully flexible retrieval system, we need to build in 'feedback' to the enquirer at various stages of the process."



Much of his ensuing discussion is related to the problem of adequate description language. If the Query Formalizer were perceived as a human agent whose vocabulary and conceptual field overlapped that of the Enquirer, many of the problems disappear and the model becomes effectively the one most commonly in use.

It appears from data on this campus that a crucial element in the creation of any such system of information retrieval is the provision of this human agent. It should be emphasized that he is not a librarian in the usual sense of the word, but an agent divorced from the physical store (which is passive) interacting directly with colleagues engaged in the same general enterprise.

How such a person should be provided is a question having a number of alternative answers, not all of which are mutually exclusive, and which need adaptation to the academic milieu in which he might operate. He must, however, be very easily accessible. This requirement has implication both for the physical accessibility of the person and his personality attitudes which permit him to be perceived as approachable.

Bibliography

Adkinson, Burton, "National System for Libraries," *EDUCOM* vol. 1, no. 8: 11, December 1966.

Boyer, Ernest LeRoy, "New Ties that Bind SUNY," *EDUCOM* vol. 1, no. 4: 1-2, 9-10, April 1966.

Diebold, John, "The New World Coming," *Saturday Review* pp. 17-18, July 23, 1966.

"Digital Computer Needs in Universities and Colleges," *EDUCOM* vol. 1, no. 3: 1-2, 8-10, March 1966.

Evans, Luther H. and Arnstein, George E., editors, *Automation and the Challenge to Education,* National Education Association of the United States, Washington, 1962, 190 pp.

Fano, R. M. and Corbato, F. J., "Time Sharing on Computers," *Scientific American* vol. 215, no. 3: 129-140, September 1966.

Greenberger, Martin, editor, *Computers and the World of the Future,* the M.I.T. Press, Cambridge, Massachusetts, 1962, 340 pp.

Kranzberg, Melvin, "Computers: New Values for Society," *The New York Times,* January 9, 1967, sec. C., pp. 135-137.

Langlary, John W., *Man-Machine Systems in Education,* Harper and Row, New York, 1966, 235 pp.

Marke, Julius J., *Copyright and Intellectual Property,* published by the fund for the Advancement of Education, the Georgian Press, Inc., New York, 1967, 112 pp.

Montgomery, Edison, "EDUCOM — The Evaluation of an Idea," *EDUCOM* vol. 1, no. 5: 1-2, May 1966.

"Network Study," news and notes, *EDUCOM* vol. 1, no. 5: 12, May 1966.

New England Board of Higher Education, "Regional Library

Computer Center Under Study," *Higher Education in New England* vol. 10, no. 3: 1, 7, Autumn, 1966.

Sarnoff, David, "No Life Untouched," *Saturday Review,* pp. 21-22, July 23, 1966.

Silberman, Charles E., "Technology Is Knocking at the Door," *Fortune,* pp. 120-125, 198, 203-205, August 1966.

Smith, William D., "Computers: Instruments for Change," *The New York Times,* January 9, 1967, sec. C., pp. 135, 137.

Sutherland, Ivan E., "Computer Inputs and Outputs," *Scientific American* vol. 215, no. 3: 86-96, September 1966.

Witherspoon, John P., and others, *Educational Communications Systems: Phase III,* final report, project no. 450A, U.S. Department of Health, Education and Welfare, Office of Education, Bureau of Research, October 1966, 300 pp.